

Math Modeling Competitions: Growing as a Researcher Through Collaborative Exploration of Real-World Problems

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What is Math Modeling?

- <https://youtu.be/xHtsuOB-TPw>
- Example Modeling Problem
 - Fresh water is the limiting constraint for development in much of the world. Build a mathematical model for determining an effective, feasible, and cost-efficient water strategy for 2013 to meet the projected water needs of [pick one country from the list below] in 2025, and identify the best water strategy. In particular, your mathematical model must address storage and movement; desalinization; and conservation. If possible, use your model to discuss the economic, physical, and environmental implications of your strategy. Provide a non-technical position paper to governmental leadership outlining your approach, its feasibility and costs, and why it is the “best water strategy choice.”

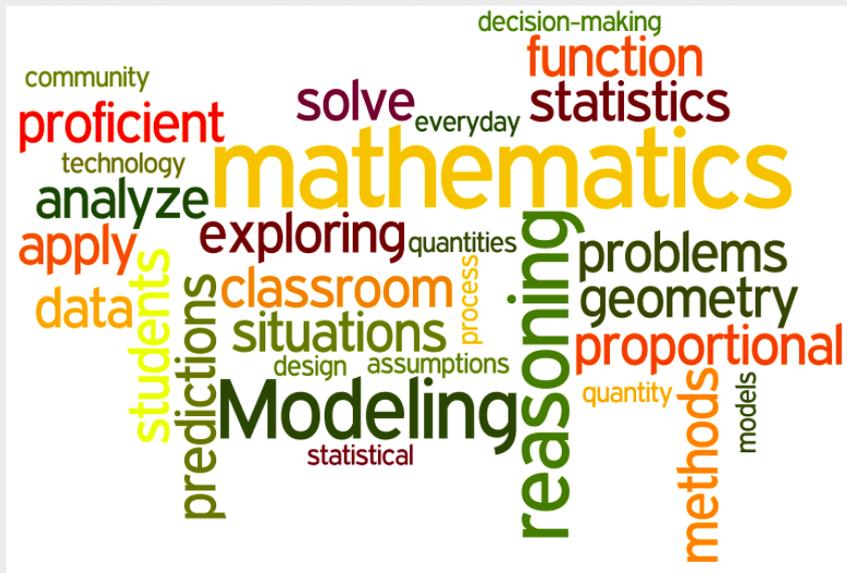
Countries: United States, China, Russia, Egypt, or Saudi Arabia

What is Math Modeling?

- How do we attack such a big problem?
 - What data do we need?
 - What do we know?
 - What assumptions can we make?
 - What are we predicting?
 - Are our predictions valid?
 - How sensitive are your predictions to the parameters of your model?

What are Math Modeling Competitions?

- Mathematically analyze a broad research problem
- Teams usually consist of 2-3 college students



- Mathematics
- Compute Science
- Engineering
- Physics

What Skills Do You Gain?

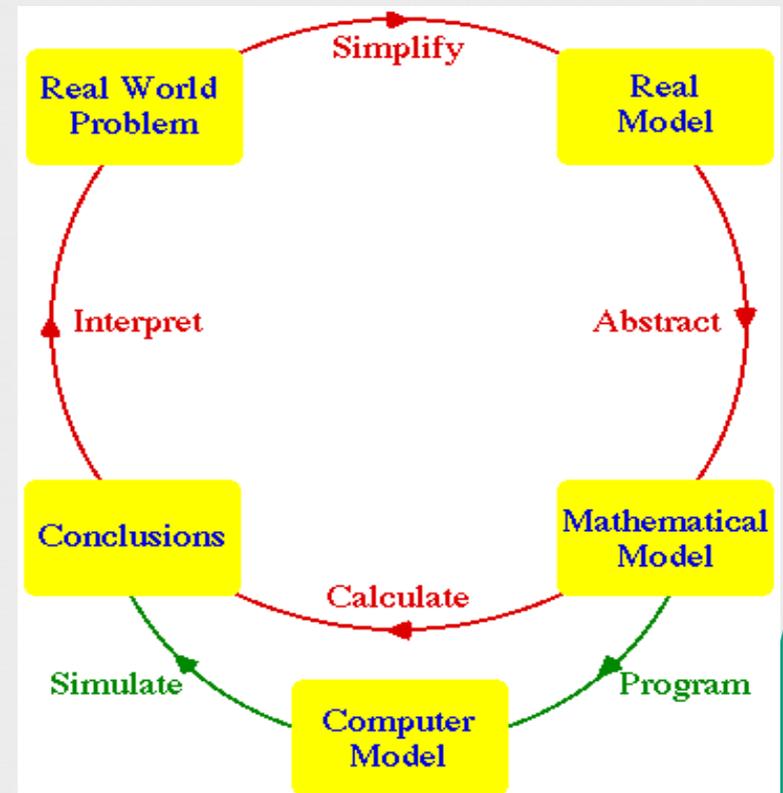
- Broaden mathematical knowledge and coding skills



- Understand how to use each teammate's strengths
 - Get exposed to other ways of thinking and scientific methods from people in different courses
- Builds teamwork under pressure

What Skills Do You Gain?

- Short introduction to how to do real-world research
 - Unlike homework, there isn't necessarily a right answer
- Builds organization and time management
- Become experienced with creating prototype solutions



How Will This Help Your Career?

- Demonstrates you can apply your mathematical knowledge, not just solve cookie-cutter problems
- Shows you can work well with a team, often under time pressure

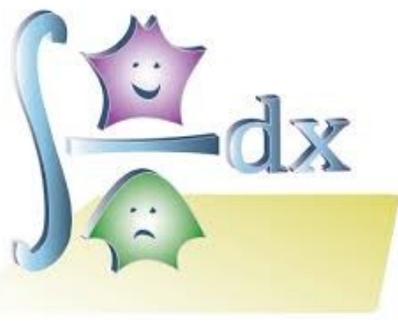
“Solving big ill/under defined questions under the pressure of time is a skill that is hard or impossible to demonstrate from coursework alone” -Undergrad professor, faculty advisor for MCM

How Will This Help Your Career?

- Specific experience with creating models (hopefully multiple models)
- Become more confident in your abilities

“[It] gives evidence that you can teach yourself enough math/CS or [other skills] in a short time to solve a specific problem.”

-Undergrad professor, faculty advisor for MCM



Why Should I Participate?

- If I'm not going to grad school, why should I do this?
 - The problems presented in these competitions are important research problems in industry, not necessarily in graduate school.

“Several financial companies make a specific point of recruiting MCM winners.” -Former MCM Outstanding Team

“When I was applying for jobs in the investment banks a year ago, the interviewers were so interested in my experience of MCM that I had to refresh my memory of our model and explain it to them.” -Former participant

Why Should I Participate?

- Why not just go to an REU or internship?

“The REU gives you an idea of what research sets you up for and the practice of working on it... [math modeling competitions are] good for students who would be working in industry, because it gives examples of what work might be like for mathematics. The REU was helpful for looking towards graduate school.” -First year graduate student, former MCM participant

Math Modeling Competition Opportunities

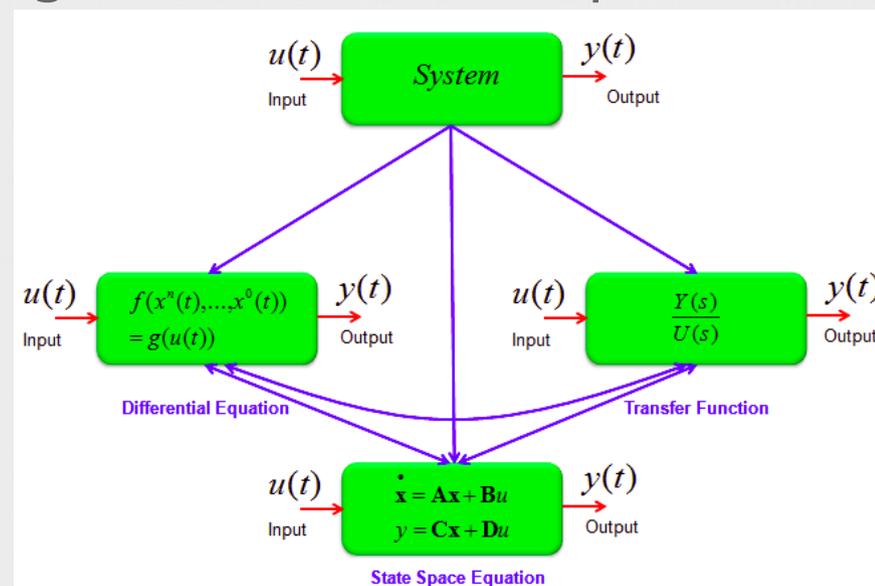
SIMIODE Challenge Using Differential Equation Modeling - SCUDEM

- Math modeling competition on differential equations
- Teams work at home institution for a week
 - Prepare Executive Summary
 - Prepare 10-minute presentation



SCUDEM

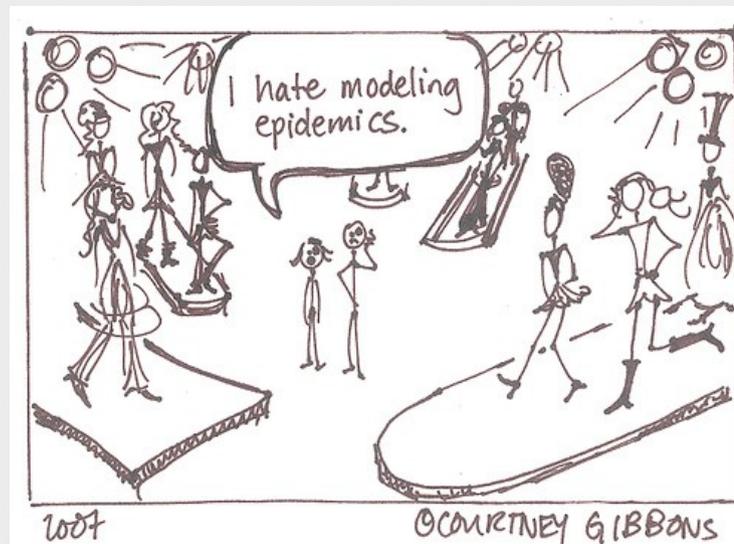
- Challenge Saturday
 - Turn in Executive summary for judging
 - Presented with a short supplement to the problem to solve
 - Update presentation with supplement
 - Faculty Development program: “...students & faculty engage in live modeling scenarios to... discuss value of modeling in learning ... differential equations.”
 - SIMIODE website
 - Fun MathBowl Trivia
 - Awards Ceremony



SCUDEM

Past Problems

- Minimal amount of resources spent by advertising company for a message to go viral
- Examine reduction/removal of drug compound from patient's system



What Do Participants Think?

“I would recommend to do this because it’s a good introduction to... doing differential equations if you have never seen them before or have a basic idea of what they are. [It’s also nice] for people who know what they are to do, because it gives them a challenge and the chance to teach people who want to know about them at the same time.” -SCUDEM 2018 II Participant

“It really challenges all your math skills you have learned thus far.” -SCUDEM II Participant

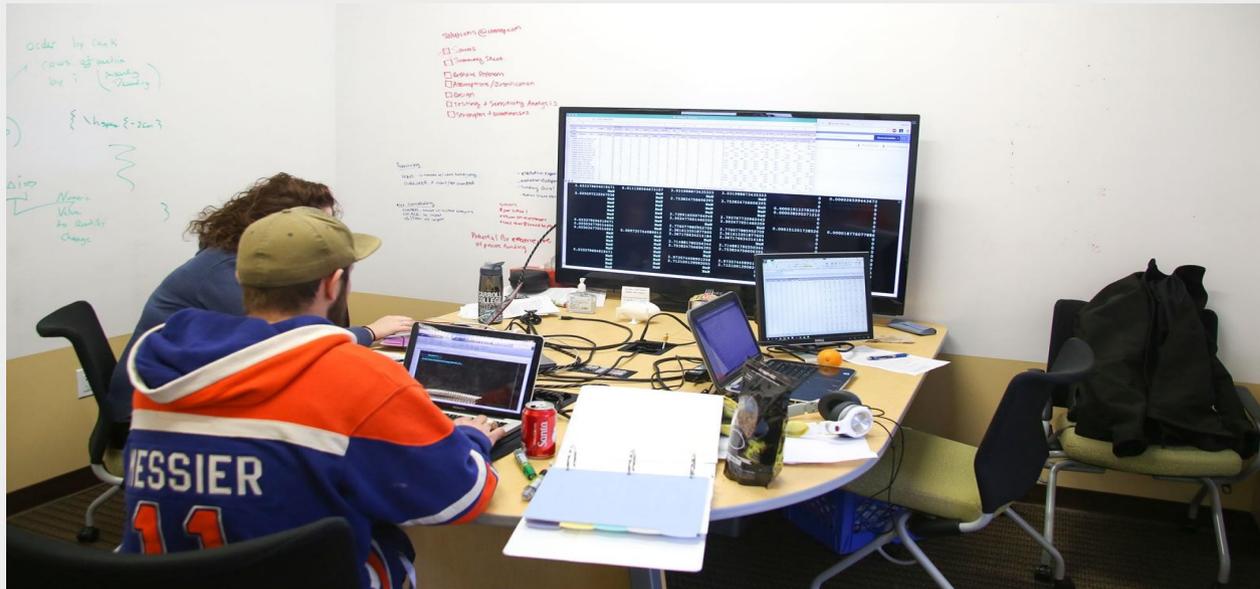
What Do Participants Think?

“I learned more about differential equations and the software packages I use at my actual job doing this [competition] than I have in weeks of doing things I’m more comfortable with. Being forced to do something that is outside of my field has been incredibly rewarding. ... I recommend this for any STEM student who has a strong background in mathematics even if they don’t think they can do it.” -SCUDEM I Participant

“It’s a real-life question; you’re doing what someone at a company might ask you to do.” -SCUDEM I Participant

Mathematical/Interdisciplinary Competition in Modeling -MCM/ICM

- 96-hour competition to solve open-ended problems
- Goal: clarify, analyze, and propose solutions to open-ended problems



- Write a 15-20+ page paper and one-page summary on your findings
- Eat lots of pizza and stay up late

MCM/ICM

- Tiers
 - Successful Participant: 60%
 - Honorable Mention: 25%
 - Meritorious: 15%
 - Outstanding: 1-2%
- Teams who participate the following year often place in a higher tier



Past Problems

- Create a search algorithm to find the crashed Malaysia flight
- Describe hunting strategy for a single velociraptor, then for a pair
- Develop a method to generate a geographical profile for police to catch serial criminals

What Do Participants Think?

“It’s really fun!... It’s cool talking to people taking other classes; you get exposed to other [methods and ways of thinking] you might not see in your coursework.” -UNL grad student, former participant

“MCM could be conducive to communication among students within divergent subjects. ... [It] facilitates the students’ awareness of and abilities to conduct research.” -Former MCM team

What Do Participants Think?

“It’s exciting that we get a problem that’s also being worked on by professional, that we can say, as college students, we developed.” -Former MCM participant

“The contest has become a previous experience and lesson for my future research.” -Former MCM Outstanding winner

References

- Math modeling competition faculty advisors and former participants first hand accounts
- <https://www.comap.com/undergraduate/contests/mcm/>
- <https://www.simiode.org/scudem>
- What is Mathematical Modeling?
<https://www.sfu.ca/~vdabbagh/Chap1-modeling.pdf>